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TESTIMONY
BEFORE THE GOVERNMENT REFORM SUBCOMMITTEE ON ENERGY AND RESOURCES
UNITED STATES HOUSE OF REPRESENTATIVES

HEARING ON FEDERAL POLICY TOWARD HYDROGEN

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Mr. Chairman and Members of the Committee, thank you for the opportunity to provide testimony on federal policy toward hydrogen and hydrogen fuel cell vehicle technologies.

I am a professor of engineering and environmental policy and director of the Institute of Transportation Studies at the University of California, Davis (ITS-Davis). I served on the 2004 National Academies committee to review hydrogen research at the U.S. Department of Energy. In December of 2002, ITS-Davis established the Hydrogen Pathways Research Program to address the very issues before your committee here today – to develop an understanding of the key technological, economic and market challenges associated with bringing hydrogen and hydrogen vehicle technologies to the market. This program receives financial support from nearly every major energy and automotive company in the world (17 in total), as well as from the U.S. DOE and U.S. Department of Transportation. Additionally, we are actively participating in other federal and state initiatives on hydrogen and fuel cell vehicle research, development, demonstration and public education. These initiatives include the U.S. DOE's *Hydrogen Fuel Cell and Infrastructure Technology* research program and *Controlled Hydrogen Fleet and Infrastructure Demonstration*, and the California Hydrogen Highway initiative announced by California Governor Arnold Schwarzenegger at our UC Davis hydrogen station in 2004. UC Davis is one of the world's leading university research centers for the study of advanced environmental vehicles and fuels including hybrids, fuel cells and hydrogen. We are happy to provide testimony on this very important subject.

My statement addresses the focus and balance of the federal portfolio of hydrogen energy research, development, and demonstration activities.

I believe that U.S. DOE management of the hydrogen program in its Office of Energy Efficiency and Renewable Energy (EERE) is not a concern. DOE is doing an excellent job in managing that program, given the constraints under which it operates. Indeed, the program managers are to be commended for developing strong relationships with the automotive industry, reaching out to the oil industry, seeking outside input in developing research programs and strategic plans, and coordinating with other federal activities. Larger issues and concerns are at stake and deserve our attention.

Non-Existent Research Policy

A primary concern is that there is no overall federal strategy to address the overarching question: How much money should be spent on clean energy R&D, for which technologies, and by whom? Without such an overarching plan or strategy, it is difficult to evaluate the funding of hydrogen research, development, and demonstration. I note that EERE is just one part of the federal hydrogen program. In the past, basic research was supposed to be the responsibility of the DOE Office of Science and the National Science Foundation. In response to the recommendation of the 2004 National Academies committee on hydrogen that more basic hydrogen research was needed, EERE began directing more funding at fundamental questions, as illustrated by the hydrogen storage Grand Challenge. I fully support that shift in focus (and elaborate below). The federal government, involving Congress and DOE (and perhaps others), needs to develop an integrated strategic plan for hydrogen and advanced vehicle research as part of an overall plan for clean energy research.

This strategic federal research plan on hydrogen and advanced environmental vehicle research would address the following questions. To my knowledge, they have not been addressed by the federal government, and only in passing by National Academies committees.

- How much should the federal government be spending on clean energy R&D, including hydrogen?
- How should those funds be split between basic science, technology development, and demonstrations?
- How should those funds be split between nuclear, renewables, fossil fuel, etc?
- How should funding for research be allocated among national labs, universities, and small and large companies in different industries?
- How should research be allocated among near term needs and riskier long term opportunities (across program areas and research organizations)?
- How can the hydrogen budget be insulated from the expanding practice of earmarking, which undermines effective program management?
- How is R&D funding best invested to maintain and enhance U.S. technology leadership internationally, with the goal of maintaining our strong economy?

Based on my reviews of various DOE programs and my own research, I have come to conclude that major changes are needed in the federal programs. I am certain that a strategic federal plan would come to the same conclusion.

Perhaps the most important change is a dramatic increase in basic research for renewable energy, and “clean” energy more broadly. A second desired change is to direct a larger share of this funding to universities, where the next generation of scientists and engineers are trained and where much of the breakthrough science occurs. Basic clean energy research can be a significant element in attracting and maintaining student interest in science, technology and engineering careers, as well as contributing to our global technical leadership.

The magnitude of federal funding of energy R&D is extraordinarily low given the energy challenges of the 21st Century and the huge public benefits resulting from energy investments. As David O'Reilly, CEO of Chevron, wrote in an open letter published in major periodicals earlier this month (July 2005),

> "Energy will be one of the defining issues of this century… The era of easy oil is over. What role will renewables and alternative energies play? What is the best way to protect our environment? How do we accelerate our conservation efforts? … We can not do this alone. Corporations, governments and every citizen of this planet must be part of the solution…"

With respect to R&D, what is the role of the federal government – Congress, DOE, NSF, and others – in this partnership? Clearly, Congress must take a stronger leadership role in articulating and formulating the broad outlines of a research portfolio. At present it involves itself in funding of particular programs, excessively so in the case of earmarking. But it does not step back and address the broader questions. A better prioritization and budget allocation process is needed to develop a broad plan to create an effective pipeline of science, technology and demonstration. It is difficult to make judgments about current federal energy activities because funding is dispersed across various programs and agencies. A few of us have some feel for how funding is allocated, but there is no mechanism nor document to guide us in making judgments about funding needs. Congress needs to address the questions listed above, and working with DOE and other agencies, it must develop a science and technology plan for clean energy, and hydrogen in particular.

Below is a summary of my suggestions and recommendations for federal actions to create an effective program capable of accelerating the transition to a clean energy system:

1. **Dramatically increase fundamental R&D, especially on clean energy production**. The hydrogen economy will depend on some mix of renewable energy, and fossil energy coupled with carbon sequestration. The energy industry has great motivation to invest in carbon sequestration, and is. But there is no analogous well-funded stakeholder industry with a strong incentive to invest in renewable production processes. Thus, the most important role for the federal government is to accelerate the development of renewable technologies. One large benefit to aggressively developing renewable energy is that improvements in these technologies can accrue to society regardless of when hydrogen is deployed. This is because many of the technologies can also be used for power production to supply energy to the electrical grid. The 2004 National Academies report emphasized the need for such fundamental research, recommending "targeted fundamental and exploratory research on hydrogen production by photobiological, photochemical, and thin-film solar processes."

This fundamental research would most logically be funded by the DOE Office of Science and NSF. The challenge is to determine where the opportunities lie, and where federal funding can most effectively accelerate innovation and benefit the public interest. For instance, funding for hybrid technology should be given low priority since the technology is already commercial and industry is already investing billions of dollars. Ideally, the more applied DOE offices of EERE and Fossil Energy would coordinate with

basic research initiatives elsewhere, and would provide strategic guidance to basic research in those other units.

2. Planned hydrogen demonstrations are about right in scale but would benefit from a more targeted approach. There are multiple goals for conducting technology demonstrations: technical, political, educational and economic. The temptation to satisfy all goals in a single project must be resisted. When all are targeted, the inevitable result is inefficient use of resources and reduced demonstration effectiveness. It should be kept in mind that most demonstrations don't become part of a commercialized stream of products nor an expanding fuel infrastructure. The demonstrated vehicles are obsolete the moment they are built, and most demo fuel stations are unlikely to be suited to a retail fuel system. The challenge then is to design small scale projects that each meet different needs. Yes, there is value in providing public exposure in different regions and beginning the process of educating fire marshals and the myriad local regulators. But at this time, they should be small and directly tied to a particular goal. In general, DOE should develop a greater sophistication about designing and evaluating demonstration programs – and communicating their strategy better to companies and taxpayers.

3. Dramatic expansion of clean energy funding for universities. Universities are the source of much of the breakthrough science, and train the scientists and engineers who will bring advanced technology into being. They also benefit society by encouraging an open sharing of knowledge, unlike industry researchers. The research conducted and the graduates who learn while doing this research will create the science and, in some cases, the technology basis for energy systems of the future. If energy research funding does not go to universities, the universities will shift their attention elsewhere. Indeed, that is what has happened. In the past 20 years, almost all the interdisciplinary energy centers at universities have disappeared. Almost all energy graduate education programs have been abandoned. The thinning of energy research at universities is undermining U.S. leadership in developing clean energy technology. Much increased energy funding of universities is needed to train the next generation of engineers and scientists, support innovation in the private sector, and maintain U.S. leadership in science and technology.

4. Better Congressional oversight. At present, Congress is too involved in managing programs and not involved enough in larger strategic issues. In particular, Congress needs to articulate priorities regarding the overall size of the energy research portfolio; the balance between short term and long term investments; balance between science, technology, and demonstrations; and funding mix between industry, national labs, and universities. DOE and NSF do not need Congressional review of particular programs. DOE and NSF already have a strong peer review process, make good use of the National Academies, and maintain many advisory committees that include industry and academics. Congress should instead focus on larger strategic questions.

5. Limit earmarking. The single most effective way to improve the productivity of DOE hydrogen programs would be to eliminate earmarking. Large swathes of the hydrogen budget have been earmarked the past two years. As the 2004 National Academies report on hydrogen and others have urged, Congress should restrain itself from earmarking science and technology funding.

Background on How UC Davis Is Contributing to the National Effort to Develop Hydrogen and Fuel Cell Technologies

I want to share with you the ways that UC Davis is making a difference in developing the technology, infrastructure and people to advance the state of the art of hydrogen for transportation. Due to the long transition time associated with vehicle turnover and fuel infrastructure introduction, business and policy decisions like those being considered here are being made today. These near-term decisions will affect the transportation and energy sector for many years to come. It is important that federal policy be shaped by the best available current knowledge and that future policy be shaped by objective research.

Brief Descriptions of Related ITS-Davis Research

About 35 graduate students and ten faculty members are involved in advanced environmental vehicle and fuels research on the UC Davis campus. Graduates of our interdisciplinary Transportation Technology and Policy (TTP) program have obtained positions within the automotive and energy industries, academia, environmental NGOs, and government. The following is a sampling of our larger programs:

Hydrogen Pathways Research Program

The Hydrogen Pathways Research Program is a multi-year program designed to look at the near to mid-term introduction of hydrogen as a transportation fuel from a technical, economic, market, and policy perspective. Bringing together people already working on these issues, the ITS-Davis Hydrogen Pathways Research Program has engaged a broad consortium of 21 leading energy and automotive companies and government agencies, including Air Products, BP, California DOT, Chevron, ConocoPhillips, ExxonMobil, General Motors, Honda, Indian Oil Corporation, Natural Resources Canada, Nissan, PG&E, Petrobras, Southern California Gas, Shell, Subaru, Total, Toyota, U.S. EPA, and the U.S. Department of Energy and U.S. Department of Transportation .

Fuel Cell APUs: A $3 million project is developing and testing fuel cell auxiliary power units (APUs) that power truck-trailer refrigeration and other auxiliary systems. The new APUs could eliminate the need for idling big-rig diesel engines, which is inefficient, expensive, noisy, and polluting. Fuel cell APUs could also power electric systems in aircraft, leading to fuel savings in the nation's future commercial aircraft fleet.

Advanced Vehicle Modeling: ITS-Davis researchers conduct extensive computer modeling of vehicle and heavy-duty truck emissions, fuel economy and performance. ITS-Davis recently completed a five-year, $3 million fuel cell vehicle modeling program that was sponsored by 20 companies and three government agencies.

Hybrid Vehicle Prototypes and Component Evaluations: The UC Davis Hybrid Vehicle (HEV) Driveline Research and Design Center designs and builds vehicles that demonstrate improved overall efficiency, high fuel economy and low emissions. The HEV Center's current efforts focus on plug-in hybrid-electric vehicles (HEVs) and continuously variable transmissions (CVTs). Researchers at ITS-Davis study energy storage and

conversion technologies (including ultracapacitors) for electric, hybrid-electric and fuel cell vehicle applications for a variety of government and industry sponsors.

New Advanced Environmental Vehicle Laboratories: The UC Davis College of Engineering and ITS-Davis are planning to build a new advanced environmental vehicle facility. This project would create large synergies by clustering UC Davis clean-vehicle research and education programs. The facility would include high-bay vehicle laboratory space, a distributed computing facility and a hydrogen refueling station. Co-funding from public and private sources is currently being sought.

Graduate Education

We are especially proud of the success of our expanding graduate education and research program much of which involved advanced fuels such as hydrogen and advanced electric-drive vehicles. The National Science Foundation awarded ITS-Davis a $2.6 million Integrative Graduate Education and Research Traineeship (IGERT) grant for our innovative Transportation Technology and Policy graduate program, the only transportation institute in the country to be funded. In addition, the U.S. Department of Energy awarded UC Davis two (of ten nationally) Graduate Automotive Technology Education (GATE) Centers – to ITS-Davis for fuel cell vehicles and to the Department of Mechanical and Aeronautical Engineering for hybrid electric vehicles. UC Davis won the first two (1998 and 2001) FutureCar and FutureTruck competitions sponsored by the U.S. Department of Energy and the USCAR program of the U.S. auto makers, and placed second overall in the 2003 FutureTruck competition.

Selected ITS-Davis Publications:

Daniel Sperling and James S. Cannon, *The Hydrogen Energy Transition: Moving Toward the Post-Petroleum Age in Transportation.* (Elsevier, 2004).

Daniel Sperling and Joan Ogden, *The Hope For Hydrogen*, Issues in Science and Technology. (Washington, D.C.: National Science Foundation, April 2004). (ITS-Davis Research Report UCD-ITS-RP-04-19 http://www.its.ucdavis.edu/pubs/pub2004.htm.

Lipman, Timothy, D. Kammen, D. Sperling, and J. Ogden, "An Integrated Hydrogen Strategy for California," Report to the Kirsch Foundation, *ITS-Davis*, RR-ITS-RR-04-43, August 2004. http://www.its.ucdavis.edu/publications/2004/UCD-ITS-RR-04-43.pdf

The ITS-Davis reports and articles, along with additional information on our programs are available at www.its.ucdavis.edu AND http://hydrogen.its.ucdavis.edu.